

MULTIMEDIA



UNIVERSITY

STUDENT ID NO

--	--	--	--	--	--	--	--	--	--

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2015/2016

**EBI 4016 – BIOELECTRIC
(BE)**

10 OCTOBER 2015
9:00 a.m – 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 6 pages with 5 Questions only.
2. Attempt all 5 questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

Question 1

- (a) What is bioelectricity and state its origin. (2 marks)
- (b) The following steady-state concentrations and permeabilities are given for a cell membrane at room temperature (25 °C) in Table Q1.

Table Q1			
<u>Ion</u>	<u>Cytoplasm (mM)</u>	<u>Extracellular Fluid (mM)</u>	<u>Ratio of Permeabilities</u>
K ⁺	145	3.5	1.1
Na ⁺	16	117	0.022
Cl ⁻	6	87	0.376

If the Universal Gas Constant, R is $8.3145 \text{ JK}^{-1}\text{mol}^{-1}$ and the Faraday's constant, F is $96485.3 \text{ Cmol}^{-1}$, then:

- (i) Find the Nernst Potential for each ion (3 marks)
- (ii) Find the Resting Potential of the cell (2 marks)
- (iii) Explain why the Resting Potential does not equal the Nernst potential for any of the ions. (3 marks)
- (c) State the major factors that influence the permeability of particles across a gap junction channel? (4 marks)
- (d) Two types of integral proteins structures contributing to bioelectric behavior of cells are pumps and channels. Channels can be sub-divided into active and passive channels. Explain the operation of pumps and channels giving particular attention to the difference between active and passive channels. (6 marks)

Continued

Question 2

- (a) State the purpose of biopotential electrodes.

(2 marks)

- (b) Electrolytes provide an environment for ion movement and when an electric field, metal ions are drawn to the vicinity of a metal surface of an electrode forming what is called, a Helmholtz layer before Redox, or oxidation-reduction reactions occur. Explain how biopotential electrodes enable bioelectric signals to be measured in the context of Redox reactions.

(7 marks)

- (c) The interaction between metal in contact with a solution of its ions produces a local change in the concentration of ions in solution near the metal surface. This causes the electrolytes surrounding the metal to be at a different electrical potential from the rest of the solution, known as the half-cell potential.

- (i) State the three parameters that determine the half-cell potential

(3 marks)

- (ii) State why half-cell potentials are important in biopotential electrodes.

(2 marks)

- (iii) Explain the offset potential in the context of biopotential measurements.

(6 marks)

Continued

Question 3

- (a) (i) Explain the sequence of mechanical events that define a cardiac cycle
(5 marks)
- (ii) Sketch a typical electrocardiography (ECG) waveform, labeling the major waveform features and relate the features of the waveform with events of the cardiac cycle
(5 marks)
- (b) Electromyogram (EMG) reflects electrical activity of skeletal muscles and contains information about the structure and function of muscles, which make different parts of the body to move.
- (i) Briefly describe the benefits of an EMG
(3 marks)
- (ii) Briefly describe the skeletal muscle and the smooth muscle
(4 marks)
- (iii) Briefly describe the Motor Unit Action Potential (MUAP) in the context of EMG
(3 marks)

Continued

Question 4

- (a) Excitable cells can be activated by a variety of stimuli. The most common method of stimulating excitable tissue is to pass an electrical current through the target tissue.
- (i) Briefly describe Functional Electrical Stimulation (FES) and Functional Nerve Stimulation (FNS) and give one example for each of the two.
(4 marks)
 - (ii) Explain the physiology of electrical excitation of cells and tissues in terms of unmyelinated and myelinated axons.
(7 marks)
- (b) In extracellular stimulations, electric stimulation usually involves delivering the stimulating currents between a pair of electrodes placed near (but not inside) the target cells. Stimulation modes depend on the arrangement of the electrodes. State the three types of stimulation modes.
(3 marks)
- (c) Surface and implantable electrodes play important roles in FES.
- (i) Briefly describe the purpose and operation of the surface electrode used in FES.
(3 marks)
 - (ii) Briefly describe the purpose and operation of the implantable electrode used in FES.
(3 marks)

Continued

Question 5

- (a) (i) Describe the purpose of biopotential amplifiers (3 marks)
- (ii) State the major characterizing parameters for biopotential amplifiers (6 marks)
- (b) Describe how powerline interference affects biopotential amplifiers (6 marks)
- (c) Understanding frequency content of bioelectric signals is crucial in maximizing recording quality. For bioelectric recordings such as the Electromyogram (EMG), cell neural spikes show no significant difference in wave shape with amplifier bandwidths at about 5 kHz. However, wider bandwidths tend to admit disproportionately more noise than the signal, creating the need for a filtering circuit.
- (i) Briefly explain why both high pass and low pass filters are needed in biopotential recordings. (3 marks)
- (ii) Briefly describe why and under what circumstances do sharp cutoff filters should be avoided in biopotential measurements (2 marks)

End of Paper